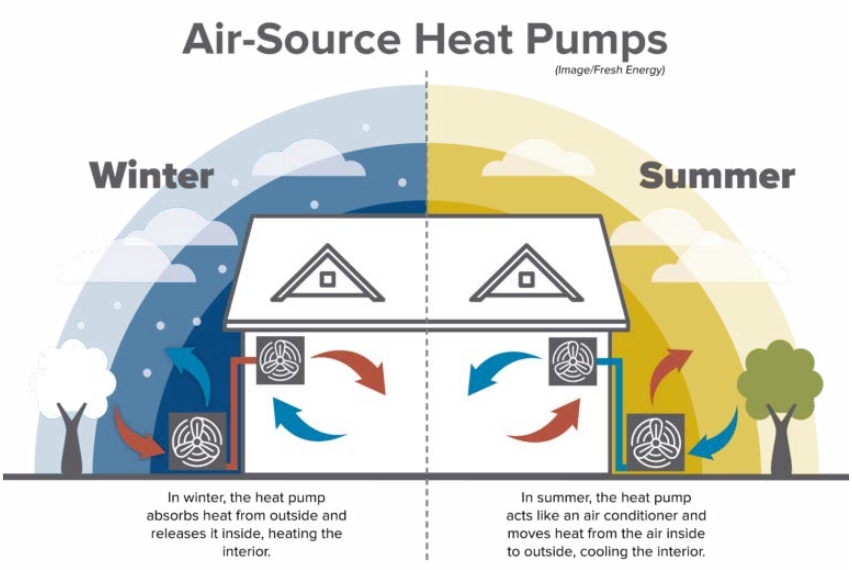
EXPLAINER: COLD CLIMATE HEAT PUMPS

Through the emissions of greenhouse gases, human activity has caused the global surface temperature to increase 1.1°C above the 1850-1900 levels in 2011-2020. Burning fossil fuels traps the sun's heat and therefore raises temperatures on Earth – this is called the greenhouse effect. This has consequential environmental, economic, and human health impacts around the world. To slow and eventually halt these changes, we must increase our resilience and reduce our greenhouse gas emissions through decarbonization.

Currently, building construction and operations account for approximately 40% of global carbon emissions. However, homes across the world are beginning to undergo a green transition, becoming more energy efficient and already experiencing the benefits. For example, LEED-certified homes, homes that meet the standard of the LEED for Homes green building certification program, consume 20-30% (up to 60%) less energy than a non-green home, lowering their energy bill comparatively.

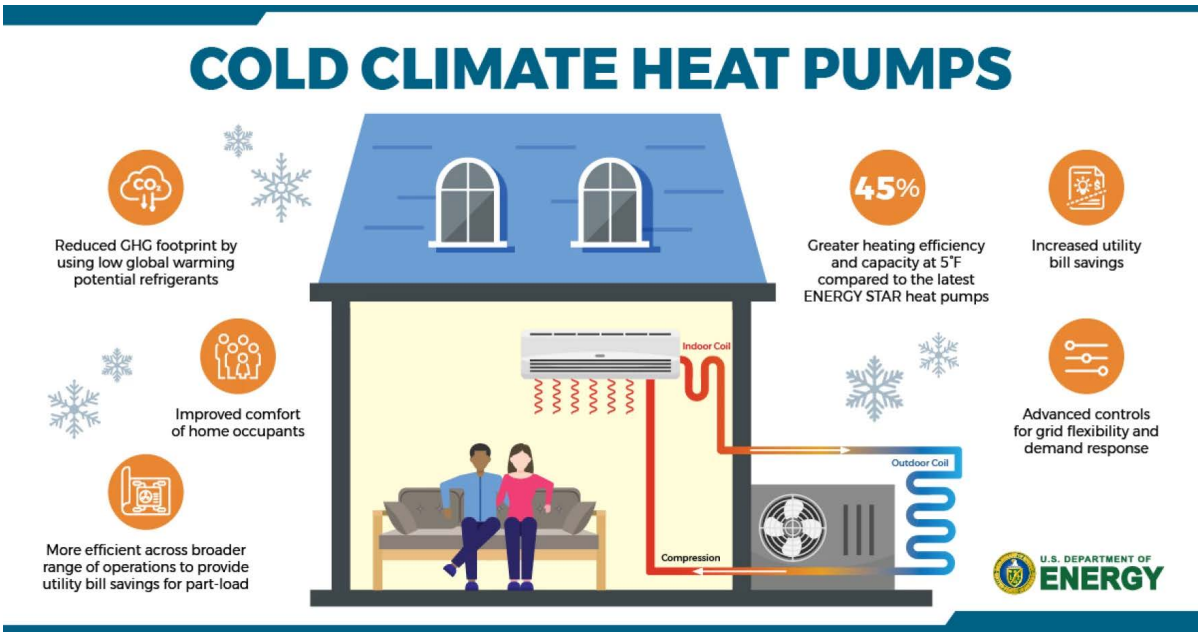
Energy efficiency is one of the major pathways to transitioning to a low-carbon economy, and because a significant portion of our emissions come from buildings, there is a lot of potential here for savings.

Air-source heat pumps (ASHPs) are a partial solution, offering energy-efficient and low-cost heating and cooling to all kinds of homes. In general, there are many benefits to installing heat pumps: they serve as a dual system for heating and cooling, removing the need for an additional system to be installed and instead allowing the technology to be used throughout the entire year. Additionally, this technology is not only safer due to the absence of onsite combustion, but also offers a cleaner system as the emissions associated with their operation are continually decreasing. Solar panels can be installed at the site to generate clean energy that will power the heat pump, and if the building envelope is well designed and the heat pump installed is sized appropriately, then the electricity generated from these solar panels might be enough to power it in its entirety. This will not only lead to lower operating costs in the long run, but also create less dependency on the grid's supply.



HOW CCHPs WORK

Cold climate heat pumps (CCHPs) have enhanced features, allowing them to operate particularly well in cold weather conditions. Just like a conventional air-source heat pump, CCHPs concentrate and transfer heat rather than generating it directly. When heating a space, liquid refrigerant absorbs heat from the air through the outdoor coil and evaporates. The refrigerant then passes through the indoor coil and releases this heat into the indoor space through condensation. A reversing valve near the compressor is employed to alter the direction, enabling the system to switch to cooling mode.



CCHP's enhanced features include:

- **DC inverter compressors**, which help absorb heat from colder temperatures and are more efficient than AC compressors.
- **A variable speed drive**, an important element as it reduces cycling, prolonging the compressor's life. CCHPs run more frequently and for longer periods of time, shortening the life of the system, so this is especially important.
- In some CCHPs, a **heating belt** is mounted around the compressor to allow the heat pump to operate in colder winter conditions.
- **An auto-defrost system**, as the outdoor coil has to be colder than the surrounding air to extract heat from sub-zero temperatures, avoiding the problem of frost build-up. The water from the defrosted coils ends up in the base pan of the outdoor unit.
- An **element heater** is added to the base pan to prevent ice from building, allowing the water to exit freely.
- **Refrigerants** with a lower boiling point are used to allow for continuous flow.

IS A CCHP RIGHT FOR YOU?

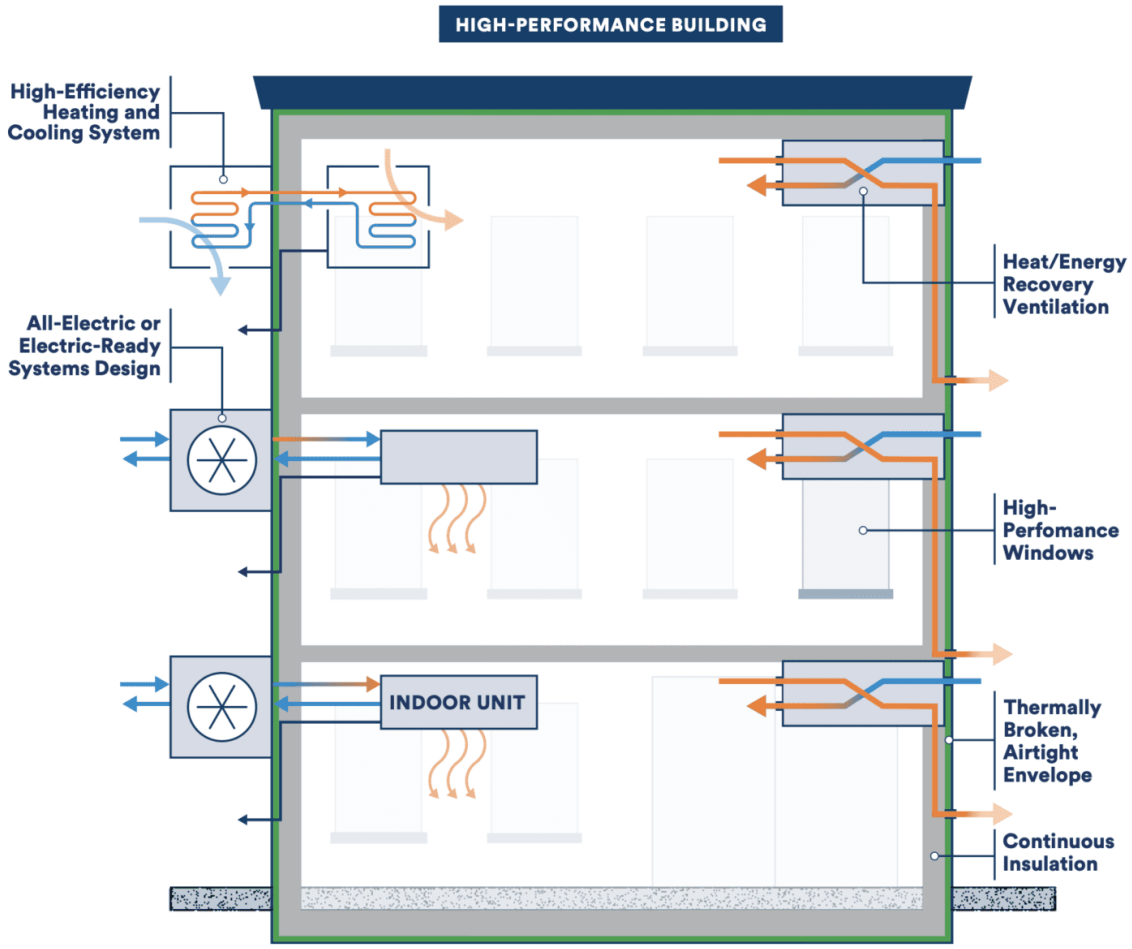
Heat pumps can be installed in all kinds of homes and benefit almost any homeowner.

Though they have a larger upfront cost, comparing the costs of natural gas with electricity, the monthly payments, as well as the environmental impact leads many homeowners to realize the benefits of a heat pump. They work best in highly insulated properties, which is why modern, new buildings are often the ideal candidate for a heat pump. However, the technology is worth considering any time you need to upgrade or replace part of your HVAC system. This might be because you need to replace your central AC, you want to heat a room that is often cold, you heat your home with fuels like propane or oil, or your main aim is to decrease your carbon footprint.

CCHPs are used in geographic regions where the temperature drops below a certain limit. If you live in a region that experiences cold climate, it is important that your heat pump is equipped to function in low temperatures.

TYPES OF HEAT PUMPS

There are two main ways for the conditioned air to be distributed when installing ASHPs (ducted vs ductless). **Ducted ASHPs** have the refrigerants travel from an outdoor unit to an indoor coil that is usually found in the mechanical room. They then use existing or newly installed ductwork to transfer cool or heated air in each room. **Ductless ASHPs** will have an outdoor and indoor handling unit that is mounted directly to the wall and includes a fan to circulate the air. (See diagram below.)



There are several types of ASHPs:

- **Mini-split systems** are the most common type of heat pumps. They have one inside unit, and one outside unit.
- **Package terminal heat pumps (PTHP)** combine all the components in a single package.
- **Multi-split systems** are installed to provide zones heating and cooling. They have one outdoor unit that services two or more indoor units. Although each zone has its individual thermostat, the system can only operate in heating mode or cooling mode.
- **Variable refrigerant flow (VRF) heat pump systems** are more complex multi-zone systems. They can handle different loads and provide either heating or cooling to each indoor unit.

Choosing the right heat pump is crucial for the successful installation and use of the system. The Northeast Energy Efficiency Partnerships (NEEP) developed a Cold Climate Air Source Heat Pump Product Search Engine ASHP (neep.org). This search engine is a preliminary product that can be used by end users to help with their decision.

FUNDING AND INCENTIVE PROGRAMS

The cost of retrofitting versus new construction is very dependent on the state of the existing building, as well as the subsidies and government incentives available. **Incentives can come from three sources - the state, the federal government, and the utility provider.** CFHF provides up to $25,000/unit to electrify space heating and cooling, and domestic hot water production. Funding opportunities are constantly changing – check out the financial incentives section on our resources page for current information on ways to fund your project alongside a CFHF grant.

In conclusion, continuous enhancements are being made to CCHPs, leading to improved energy efficiency at lower temperatures. With the construction industry increasingly aiming for carbon neutrality, CCHP technology plays a role in achieving this goal. A comprehensive understanding of the various elements involved in heat pump installation is essential for optimizing its functionality. This encompasses factors like existing building conditions, technology selection, and installation procedures. Mere availability of the technology is not sufficient; effective education and incentives are necessary to ensure users grasp the mechanics and impacts of these systems, enabling confident utilization and installation in their own spaces.

REFERENCES AND RESOURCES

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